Assessment of Albedo Derived from MODIS Data

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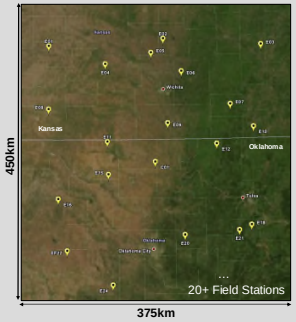
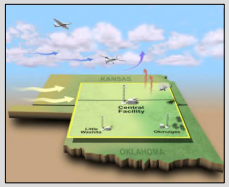
The MODerate-resolution Imaging Spectroradiometer (MODIS) Bidirectional Reflectance Distribution Function (BRDF)/Albedo algorithm makes use of all cloud-free, atmospherically corrected, directional surface reflectances available over a multi-day period to retrieve a 500 m land surface BRDF. This BRDF is then integrated over all view and azimuth angles to give directional hemispherical reflectance (black-sky or completely direct albedo) and bihemispherical reflectance under isotropic illumination (white-sky or wholly diffuse albedo). We investigated the main sources of surface albedo variability in the Southern Great Plains (SGP) region, at different time scales, ranging from daily to inter-annual variations, by combining in-situ and satellite measurements in a geostatistical framework. Daily measurements of the Bidirectional Reflectance Distribution Function (BRDF) and surface albedo were collected at several Atmospheric Radiation Measurement Program (ARM) field stations in conjunction with multiangular and multispectral observations from MODIS and NASA's Cloud Absorption Radiometer (CAR). Once point-and-pixel comparisons were made, a regional scaling phase uses the tools of geostatistics and digital imaging to properly extend point albedos over the full regional extent of the SGP for comparison with MODIS image retrievals at the scales at which climate models are commonly utilized. Finally, the spatial characteristics between finer scale BRDFs and MODIS retrievals were compared in a well characterized atmospheric regime by evaluating their capability to reproduce the directional signatures as observed by the CAR instrument. This work will lead to the creation of a new confidence layer for the MODIS BRDF/Albedo product, which will provide pixel-specific accuracy to regional and global modeling efforts.

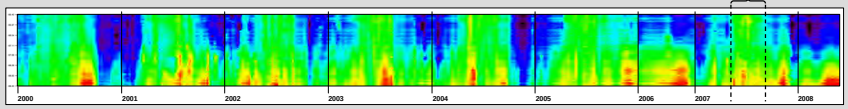
I. Cloud and Land Surface Interaction Campaign (CLASIC)





Fundamental to the objectives of CLASIC is the understanding of the interactions between the atmosphere and the land surface. Surface measurements were primarily retrieved over four stations in the Southern Great Plains with dominant land uses/covers such as winter wheat/stubble, grassland, irrigated crops, and forest canopies.

II. Temporal Characterization



Time versus longitude diagram of MODIS White-Sky Albedo (0.3-3.0um) averaged from 99.40W (West SGP) to 95.40W (East SGP)

This survey allows us to discriminate surface albedo variability in space and time for the major land use/cover characteristics observed in the Southern Great Plains (i.e. forests, pasture, wheat, alfalfa, corn, cotton, soybean, and urban).

http://www-modis.bu.edu/brdf

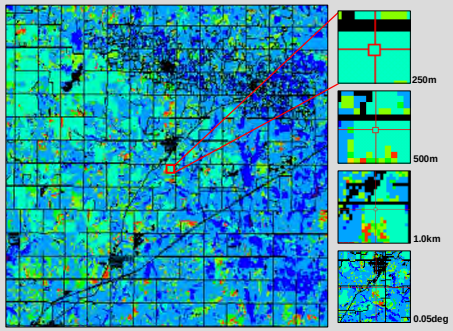
III. Local Upscaling:

We are performing pixel-based assessments of surface albedo through comparisons of point measurements at the ARM-SGP stations and MODIS values at 250 m, 500 m, 1 km, and 0.05 deg using the following methods:

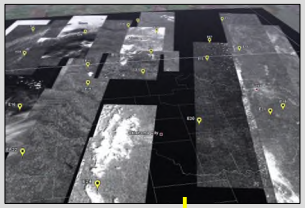
-Direct comparisons of MODIS albedos to tower measurements.

-Comparisons of MODIS albedos to measurements of the dominant land cover class.

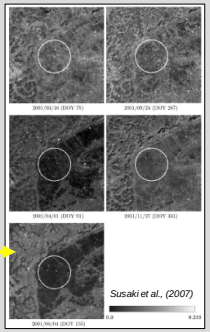
-Comparisons of MODIS albedos to a weighted fraction of land cover classes.



Local Upscaling at the ARM EF-24 Facility (Cyril, OK)
CLASIC-AWiFS Land Cover Dataset -- courtesy of Michael Cosh (USDA-ARS)

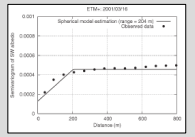


A large number of ASTER, IKONOS, and Quickbird scenes, in some cases multiple images from 2006-2007, help us discern fine scale variability.



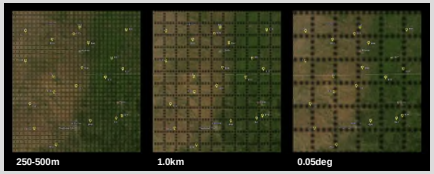
Measurement site and homogeneous area around the site on five Landsat ETM+ scenes.

Semivariograms obtained as a function of time $\gamma(h,t)$



- **Semivariogram results from ASTER, IKONOS, or Quickbird data (top-image). These plots enable us to examine whether the lands surrounding the 20+ field stations in the SGP region are homogeneous.**
- **Additional comparisons of temporal ASTER SWIR albedos normalized to a common noon geometry provide enhanced assessments of surface albedo change patterns over time.**

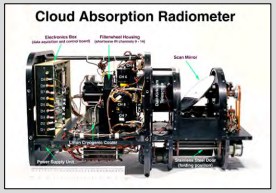
Assessment of Spatial Albedo Fields over the ARM/SGP Region



IV. Regional Upscaling: We are performing semivariance analysis (including variogram modeling) using field measurements and the CLASIC land cover dataset (50 m resolution) to come up with surface albedo fields over the SGP. Using these results as our ground-truth estimate, we will scale the fields using 250 m, 500 m, 1 km, and 5 km grids to compare it to MODIS datasets.

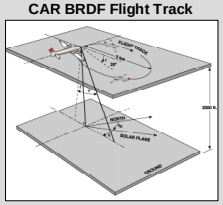
Spatial Characterization of MODIS/BRDF retrievals from CAR

Cloud Absorption Radiometer

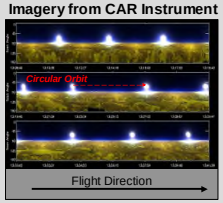


V. The Cloud Absorption Radiometer (CAR) was deployed on several flights by NASA's Jetstream 31 (J-31) during CLASIC (Summer 2007). The availability of the airborne CAR data, as well as additional high resolution imagery allows for a more rigorous scaling of ground-based measurements up to the moderate resolution MODIS footprint in this region of heterogeneous surface covers.

CAR BRDF Flight Track



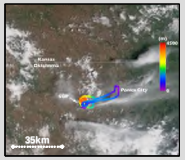
Imagery from CAR Instrument



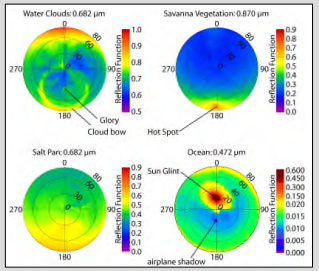
VI. To measure the BRDF, multiple circular orbits were acquired under clear sky conditions over the ARM Central Facility (CF-01). The top-left figure shows a typical flight pattern whereby the aircraft, with the CAR in the nose cone, flies a clockwise circular pattern above the surface repeatedly, drifting with the wind, scans the underlying surface and much of the transmitted solar radiation from above. The circular orbits (as noted in the bottom-left figure) are then averaged together to smooth out the reflected solar radiation signal. Because of its lower altitude, CAR is also able to estimate the BRDF at a higher spatial resolution (10-200 m spatial resolution – depending on view angle) than MODIS (500 m). CAR retrievals can therefore be used to evaluate BRDF inversions to address upscaling needs for MODIS-derived surface anisotropy and albedos and further explain the discrepancies noted previously, at least for the period of CLASIC.

CLASIC Campaign (Ponca City, OK)

J-31 Flight Track Map



Post-Calibration at NASA Goddard



VII. Upscaling CAR retrievals to MODIS: We are reconstructing BRDF retrievals from CAR (seen here for various land, ocean, and cloud scenarios) into the parameterizations used by the MODIS algorithm. Once an assessment of the MODIS BRDF/Albedo products' ability to capture the underlying surface reflectance is accomplished, we will turn our attention to the quality of the BRDF retrievals to more fully quantify the product's ability to accurately model the effects of surface reflectance anisotropy with sparse satellite observations by making use of the unique multiangular data offered by the CAR instrument.

http://car.gsfc.nasa.gov